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METHODS OF SAMPLING GREY IRON AND
MALLEABLE IRON CASTINGS

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Indian Standard

METHODS OF SAMPLING GREY IRON AND MALLEABLE IRON CASTINGS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 June 1982, after the draft finalized by the Methods of Sampling Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Grey iron and malleable iron castings find extensive use in engineering and processing industries both as components as well as final products. The selection of right type and grade depends on the end use of the castings. However, there are certain basic physical and chemical properties which are common and need to be controlled during production and checked at the time of purchasing.

0.3 Proper quality control during the process of manufacture would substantially reduce the quality fluctuations of the end products. This requires frequent inspection and testing at various critical points of production and also at the finished stage.

0.4 This standard aims at providing unified sampling plan for acceptance of grey iron and malleable iron castings. For intricate and special castings the sample size could be increased on agreement between the purchaser and the supplier. Some guidelines have also been provided for process inspection.

0.5 The standard contains clause **4.4.3**, **4.4.4** and **5.5** which call for agreement between the purchaser and the supplier.

0.6 In reporting the result of a test or analysis, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

*Rules for rounding off numerical values (revised).

1. SCOPE

1.1 This standard prescribes the methods of sampling and criteria for conformity for deciding the acceptance or rejection of a consignment of grey iron or malleable iron castings. The broad outlines regarding the controls to be exercised during the manufacturing process have also been indicated for guidance.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Item — Individual casting meant for inspection or testing.

2.2 Lot — The total number of iron castings of the same type, grade and size originating from the same heat treatment batch. A consignment offered for inspection may consist of one or more lots.

2.3 Lot Size — The number of grey or malleable iron castings in the lot.

2.4 Sample — Item selected for inspection and/or testing from a lot.

2.5 Sample Size — The number of items selected for inspection and/or testing from a lot.

2.6 Defect — Failure to meet the requirement imposed on an item with respect to a single characteristic.

2.7 Defective — A casting having one or more defects.

2.8 Acceptance Number (a) — The maximum permissible number of defectives in the sample(s) for acceptance of lot.

2.9 Acceptable Quality Level (AQL) — The maximum percent defective that, for the purpose of sampling of a certain grade or type of iron casting, can be considered satisfactory as a process average.

NOTE — When a purchaser designates some specific value of AQL, he indicates to the supplier that his (purchaser's) acceptance sampling plan will accept great majority of the lots that the supplier submits, provided that the process average level of percent defective in these lots is not greater than the designated value of AQL. Thus AQL is a designated value of percent defective that the purchaser indicates will be accepted most of the times (approximately 89 to 99 percent of the times).

3. PROCESS CONTROL

3.1 The object of inspection and testing of grey and malleable iron castings by the purchaser is to ensure their conformity to the requirements of the specifications agreed upon, whereas the inspection and testing carried out by the manufacturer during production is to ensure

conformity to the relevant specification as well as to maintain a satisfactory control over the process. Quality control during production can build the quality and reliability into the casting whereas inspection done at a later stage can only help decision regarding the acceptability of a given quantity of castings. Hence it is highly desirable that the manufacturer should have his own scheme of sampling and testing during manufacturing process so that the quality fluctuations during production can be monitored and timely action may be taken for correcting any abnormal situation.

3.2 In the manufacture of grey and malleable iron castings, testing of raw material batch-wise and also testing of sand for various characteristics is of paramount importance. Process parameters during production as well as heat treatment also highly influence the quality of iron castings. While the degree of control as stated above is left to the individual manufacturer depending on the manufacturing process, certain minimum frequency of testing is considered desirable during production of iron castings.

3.3 The recommended frequency of testing for some of the important characteristics are given below:

| <i>Characteristic</i> | <i>Frequency of Testing</i> |
|-----------------------|--|
| a) Tensile Strength | One test from each heat in the case of batch furnaces and one test from each tap in the case of cupola melting; test bars shall undergo the same heat-treatment together with the castings they represent. |
| b) Hardness | For small and medium castings, 5 percent of the total production in a batch shall be checked for hardness. For large castings (above 250 kg per piece), 100 percent checking for hardness is essential. |
| c) Micro-structure | The test bars used for tensile tests are to be examined for micro-structure wherever required. However, it has to be ensured that at least one test bar is available for each heat treatment batch. |

d) Dimensional Check

For major and critical dimensions, 100 percent of the castings shall be checked by gauges/templates or actual measurement. In respect of other dimensions, 10 percent of the castings shall be checked.

4. LOT INSPECTION

4.1 If the manufacturer has maintained an adequate and satisfactory system of quality control in the manufacture of iron castings, the resulting data and information may be made available to the purchaser along with items supplied to enable him to judge the acceptability of the consignment. When it is not possible to provide this information or if the purchaser so desires, the procedure laid down in the following clauses shall be followed for determining the conformity of iron castings to the requirements of the relevant specification.

4.2 Information regarding heat number and batch number of the castings shall be made available to the purchaser or his representative at the time of inspection. Cast/batch/melt/heat number or any suitable identification code number shall be provided on each test bar and on each casting wherever the casting size permits. On the basis of the above information, a consignment shall be constituted into one or more lots.

4.3 From each lot formed as above, samples shall be selected and tested sequentially for ascertaining the conformity to the requirements of the relevant specification.

4.4 Scale of Sampling

4.4.1 Tensile Strength and Micro-Structure — The number of tensile tests shall be as per 3.3. The required test bars shall be kept ready with all details of identification at the time of inspection. Wherever required, the same test bars shall also be examined for micro-structure.

4.4.2 Hardness — The castings in each lot shall be counted and 10 percent (subject to a maximum of 50) shall be subjected to hardness test. The sample castings shall be selected by random sampling procedures (see IS : 4905-1968*).

4.4.3 Workmanship, Finish and Freedom from Defects — All the castings in the lot shall be individually examined for the purpose of judging the workmanship, finish and freedom from defects as stipulated in respective specifications or as agreed to between the purchaser and the supplier.

*Methods for random sampling.

4.4.4 Dimensional Requirements — All larger castings shall be individually examined and checked for dimensional requirements as specified or as per prior agreement between purchaser and supplier. In the case of smaller castings the number of samples to be selected and checked from each lot shall be as prescribed in Table 1.

TABLE 1 SCALE OF SAMPLING AND ACCEPTANCE NUMBER FOR DIMENSIONAL REQUIREMENTS

(Clause 4.4.4)

| LOT SIZE (No. OF CASTINGS) | SAMPLE SIZE | ACCEPTANCE NUMBER |
|---------------------------------|-------------|----------------------|
| (1) | (2) | (3) |
| Up to 25 | 8 | 0 |
| 26 to 50 | 13 | 0 |
| 51 to 100 | 20 | 1 |
| 101 to 200 | 32 | 1 |
| 201 to 500 | 50 | 2 |
| 501 and above | 80 | 3 |

NOTE — AQL value for the above plans is approximately 1.5 percent.

4.4.5 Chemical Composition — In case maximum limit for phosphorus and/or sulphur is specified, two tests shall be conducted from each lot for these elements. For the purpose of these tests, requisite quantity of material may be taken from the test bars prepared for the purpose of mechanical tests.

5. CRITERIA FOR CONFORMITY

5.1 Tensile, Hardness and Micro-structure — The lot shall be considered to have met the requirements of the specification if all the samples taken from, the lot satisfy the requirements of the respective characteristics.

5.2 Dimensional Requirements — In case of larger castings, all the individual items shall meet the requirements of dimensional characteristics. In the case of smaller castings the lot shall be declared as conforming to the dimensional requirements if the number of defective items does not exceed the acceptance number given in Table 1.

5.3 Workmanship, Finish and Freedom from Defects — All the castings in the lot when individually examined shall be found satisfactory in respect of the requirements for workmanship, finish and freedom from defects as specified in respective specifications.

5.4 Chemical Requirements — The samples tested for the specified chemical characteristics shall meet the requirements given in the relevant specification or as specified by the purchaser.

5.5 If the lot is found unsatisfactory at any stage during the course of testing no further tests need be conducted unless it is agreed otherwise between the purchaser and the supplier.